

ASTRONOMY ACTIVITIES FOR ELEMENTARY & MIDDLE STUDENTS

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All of the observing programs that I discuss below are best done with a parent. First, it makes certain the child isn't unsupervised after dark, and second, it piques the parent's interest in astronomy, too. Most of the activities involving stars are better done in the late fall or winter, when the Sun sets relatively early and the constellations are reasonably bright, even in the city. The best time to observe the stars is a clear night just after a cold front comes through - but be sure that the child knows to dress warmly! The Moon is easy enough to spot that a clear sky isn't necessary, and it is observable even in the daytime, so that it isn't necessary to restrict it to winter observations. Of course, it can't be overcast!

THE MOON

Most elementary students recognize the Moon, both at crescent and as a full Moon stages. Many students know that the Moon goes around the earth, but it is a simple month-long project to follow the Moon's path and see how its phases are influenced by its position in the sky relative to the Sun. (And so, what time of day it appears!)

The first easy project is to just observe the Moon when it is full. Where in the sky does it appear near sunset? (in the East). Can the students sketch its appearance (dark and light features) after viewing with their naked eyes? Then by looking through a pair of binoculars? (Inexpensive ones will suffice). Every year there is an "Observe the Moon" event. You can find out the location of an event near you (or create your own event) by checking the Observe the Moon site: <http://observethemoonnight.org>.

Phases of the Moon activity

First, find out from a calendar or the newspaper the day of the new Moon. Ask your students to go outside one hour after sunset (again, get the time from the newspaper) and look just above where the Sun set to see if they can see the thin crescent of the new Moon. Generally, the Moon will not be visible until the next day, but make it a game to see whether anyone can see it that day, and who can see it first the following day (or the next). Often with a narrow crescent moon, you can see the dark part of the moon, dimly lit by "earthshine". This is called "the old moon in the new moon's arms". The Earth, as seen from the Moon, also goes through phases, and when the Moon is new, the Earth as seen from the Moon is full, and so shines brightly on the dark Moon. Have them estimate how high above the horizon the Moon is (one fist at arm's length is about 10 degrees, good for adults **and** children). Have them note what time they first saw the Moon, and have them make a sketch of how it looked. Which way was the crescent pointing? (a cup or smile pointing up, but it can appear tilted depending on the season.)

For the next two weeks, have them look for the Moon at the **same** time every clear evening. Have them estimate its height above the horizon, and draw a sketch. One week after new Moon, the Moon should be half-full (first quarter) and will be nearly overhead at sunset. Each night it can be found farther and farther towards the east, until at full Moon, it should rise just as the Sun

is setting. Can they see it at the same time the next night? When does it rise? (about an hour later). For the next week, have the students try to find the Moon in the sky in the early morning, first thing when they get to school (or before school with their parents, if there is time). The waning Moon should be visible in the west after sunrise, getting smaller and smaller as it becomes higher and higher in the sky. By the next week, it should be overhead at sunrise and down to half full again. Over the next few days it should become smaller and smaller, and farther to the east, closer to where the sun will rise. When is the last day you can see it in the morning? Now start looking in the evening again - when is the first time you can see it in the evening? That determines the month - the Moon's orbital period as seen from Earth (~29.5 days). You can make a sketch for them to show them how the Sun's light changes the apparent shape of the Moon as it goes around the Earth. Note that half of the Moon is always lit by the sun... it's just not always visible to us! (For older students, they can do the "Phases of the Moon" activity from space update: https://spaceupdate.com/activities_spaceupdate.php)

This is also a great way to find planets, since the moon, traveling in the ecliptic, will over the course of the month pass nearby all the planets that are up. Use your star charts to find the planets in the evening and morning skies. The moon's path is a great way to trace out the ecliptic. Did you know that a full moon in winter is high in the sky, like the sun in summer? A full moon in summer is low in the sky, like the sun in winter. Show them by using balls how the tilt of the Earth tilts away from the full moon if it tilts towards the Sun and vice versa. A first quarter moon in the fall is low in the sky like a winter sun; a first quarter Moon in the spring is high in the sky like a summer sun - can you use balls to show that?

CONSTELLATION IDENTIFICATION

Use a "planisphere" (available from Museums, telescope vendors, <http://earthsky.org/store>, and/or **Sky and Telescope**) to dial up the sky for the early evening of the day you are interested in. Be aware that the times shown are for "sun time." Since Houston is west of the center of our time zone, the Sun and stars rise 21 minutes later than would be true for the center of the time zone. (Use other corrections for other locations). So, if you want to look at the sky at 8 p.m. CST, dial the planisphere to 7:40 p.m. If you want to look at the sky at 8 p.m. CDT, the daylight savings means another hour of correction: dial to 6:40. Since only the brightest stars are visible from Houston, make a simplified chart for your students with only the brightest stars on it (both sides). Use a time about an hour and a half after sunset: this is what we do in the "Sky Tonight" section of our ["Space Update"](#) software - note it has evening and morning sky options, plus five look directions (North, South, East, West, and Zenith). A subscription to Sky Calendar (<https://web.pa.msu.edu/abrams/SkyCalendar/index.html>) is economical, and provides you with a start chart (including the planets), plus daily finder charts for interesting events (i.e., conjunctions of Venus and the Moon). Or download the free "Stellarium" software from <http://www.Stellarium.org/> (also available now as a smartphone app).

Practice first yourself to see which stars are identifiable from your own home. Have your student go outside with their parent(s) and try to find the star patterns. Have the parent(s) initial their star chart that they have identified two or more constellations. (The parents will enjoy helping with this homework.) Also try to identify 5 bright stars by name.

In the fall, my favorite is Scorpio – it's easy to imagine his scorpion shape and his red heart. And Sagittarius the archer is the "teapot" to his left. Orion the hunter is very bright and easy to spot (a large rectangle with a row of three stars as a "belt" in the center). It is up much of the school year - in the east late in the fall semester, in the west in late spring. Can they tell which star is red (Betelgeuse)? Following the hunter is a very bright blue star: Sirius, the dog star. Sirius, along with Rigel from Orion (his right knee), Aldebaran in Taurus, Capella in Auriga, Pollux (one of the "twins" of Gemini), and Procyon (the "little dog") makes the "winter hexagon," easily visible in the city. Similarly, the "summer triangle" is visible in the late spring. It is interesting that you can get all six "magnitudes" of stars using Orion and its neighbors...

ROTATION OF THE STAR PATTERN

Observing the constellations near the north pole is the easiest way to teach that the stars rotate around "Polaris" (the pole star). Since we are at 30 degrees north latitude, Polaris is located 30 degrees above our Northern horizon. Unfortunately, Polaris itself is the only star visible in the Little Dipper from inside the city of Houston. Two other polar constellations **are** readily observable from Houston, and since they are on opposite sides of the north star, one or the other is always visible.

The better-known constellation is, of course, the Big Dipper. Since it is located between 40 and 50 degrees from the pole, it is not always up in the sky. It is visible in Houston in the early evenings from the end of January (when it is low and to the right of the polestar, through the middle of September (when it is right-side up). At the end of April, it is upside down in the early evening. Recall that the last two stars of the bowl always point at the north star. Therefore, you can see the big dipper to watch the rotation of the sky, but only starting in February.

Another constellation that can be used (and is a little easier, since it is closer to the pole) is Cassiopeia, the Queen. Her throne looks variously like a wide "W" (in late July), an angular "3" (August through the end of March). In the late spring and early summer it is below the horizon in the early evening, rising later in the night. Play around with your planispheres to teach yourself how the stars change with the seasons. Attached as the last page of this is a finder chart for the northern stars, called "North Sky Adventures".

Select either Cassiopeia or the Big Dipper, whichever is up for the season you choose. (Try to do this during dark sky conditions - from about three days after full Moon to three days after new Moon.) Have the students sketch its position in the sky at 7 p.m., then at 8 p.m., then at 9, then at 10. (They might want to do this on a Friday night, so they can stay up late.) They can sketch in trees or other landscape items for reference, but they should stand in the same spot to do each sketch. Which direction does the sky move? Have them do the same thing one or two months later. Show them a globe and make people stand around the room, each representing a star. As you turn the globe, which star can see your location on Earth? (have them raise their hands).

DARK SKY OBSERVING

Once your students get a little familiar with the night sky as seen from the city, encourage their parents to take them out for a drive on a cool winter's evening to a place far from the city

lights (If you are in the Houston area, the George Observatory at Brazos Bend State Park is perfect, but other places would also work). How do their favorite constellations look now? How many more stars can they see? Talk to them about "light pollution" being like air pollution or water pollution. Air pollution makes it hard to breathe; water pollution kills fish; and light pollution makes it hard to see the stars from the city. If you have a camera with a manual exposure setting, try shooting a series of exposures (1 sec to 30 sec). In the city, what is the longest exposure that makes any more stars visible? How does this change in the country?

THE AURORA

Ask the students if anyone has ever seen an aurora or "northern lights." If someone has, have them describe it (dancing multicolored lights in the sky). Where were they when they saw it? (probably Canada, Alaska, or the northern United States). What do all those places have in common? (They are fairly far north.) That's why the aurora is called the "northern lights."

Show the students photos (or better yet, a video) of the aurora and its motion. What colors do they see? (green, blue and red) What do they think the aurora is like? If anyone says "a TV", they are very right - particles come in from space and hit the atmosphere and make it glow, much like electrons in a TV set make it glow. There are great photos and videos of the aurora in <http://www.spaceweather.com/> and also in our Space Update software (space weather section).

Where do the electrons in the aurora come from? (*From the Sun.*) Show them a picture of the Sun's corona during a solar eclipse. The halo part around the blacked-out Sun is called the corona. The solar wind is what comes off as the Sun boils, much like steam off a boiling pan of water. When it hits the Earth, some of its energy streams into the earth, energizing electrons that cause the atmosphere to glow when they hit it. The aurora is only seen near the poles (northern *and* southern) because the Earth's magnetic field shields us from the bulk of the solar blasts.

ECLIPSES

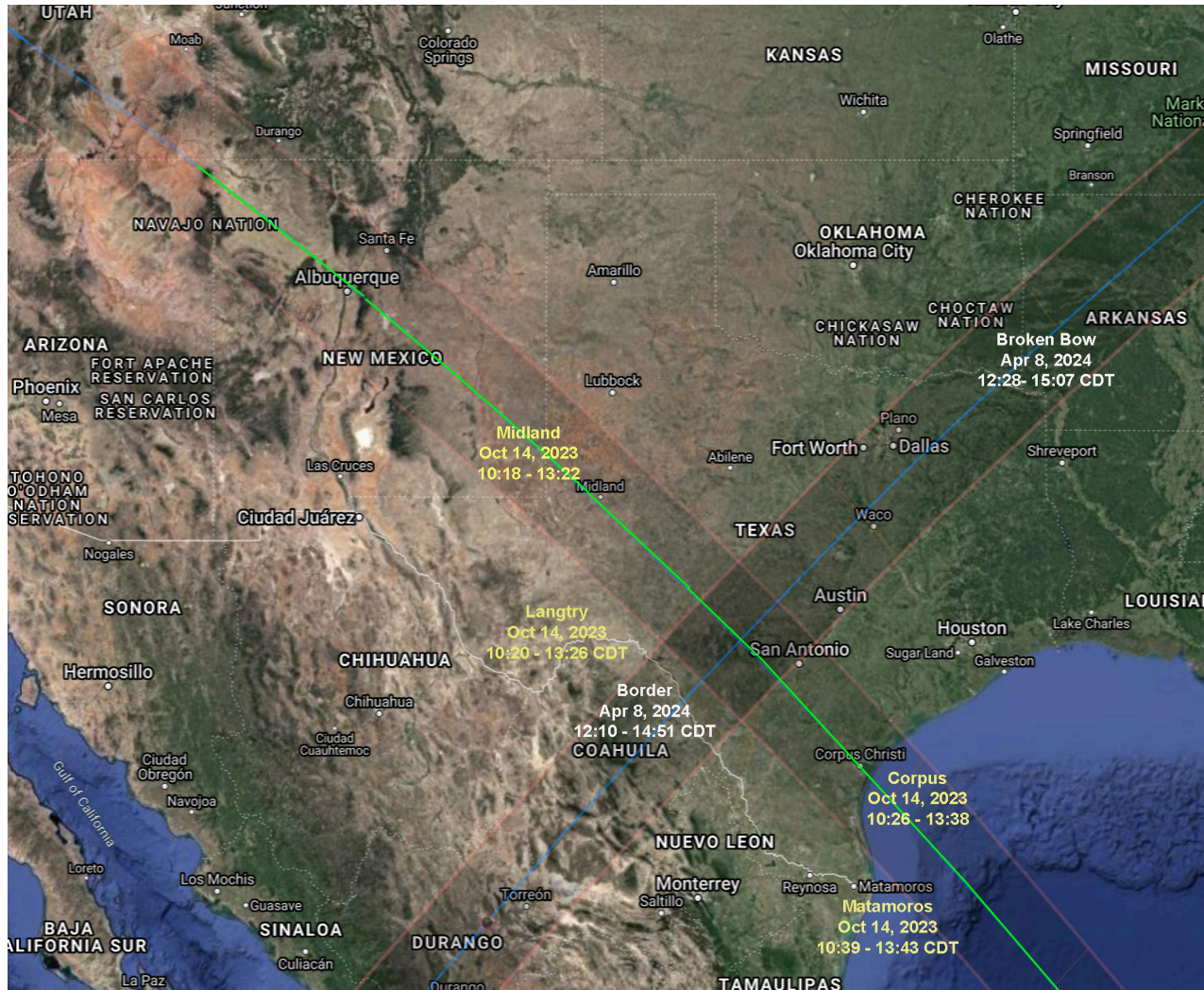
Again, ask if any of the students have ever seen an eclipse (have them describe it). Did any of the students see the solar eclipse of August 21, 2017? Did they see a partial or a total eclipse that day? If total, where were they? If partial, what fraction of the sun was covered for them?

There will be an annular eclipse on October 14, 2023 and a total eclipse across the US on April 8, 2024. These will be amazing views if you are in the path of annularity or totality.

In an annular eclipse, the moon is farther from the earth so that its disk doesn't quite cover the entire sun. A ring of uncovered sun is called "the ring of fire". No part of an annual eclipse is safe to view with unprotected eyes - you need a pair of special solar eclipse glasses or special filters for telescopes or binoculars. For the total eclipse of 2024, the partial phases of the eclipse also are dangerous, but if you are lucky enough to be in the path of totality, you can watch with your "naked eyes" and unfiltered binoculars **ONLY** during the time of totality.

To learn more about eclipses, view my eclipse page <http://space.rice.edu/eclipse/> . We will have much more information posted as the eclipses approach. (See the eclipse paths across Texas for the eclipses below). Path of maximum annularity for Oct 14 is the green "center line", with

annularity visible within the orange lines parallel to that. For that event, the sun is never completely covered, so eye protection is needed at all times. Path of maximum totality for April 8 is the blue “center line”, with total eclipses visible within the orange boundaries. If you are close (but inside) the orange boundaries, the totality will be short. If you are outside the orange boundary, it will never be total for you and it will never be safe to view with your naked eyes. 98% is not good enough – reserve yourself a space in the zone of totality soon!



Many more might have seen a lunar eclipse. Early in the morning May 26, 2021, we will have a **total lunar eclipse** visible over the western and central continental US. The lunar eclipse will be partial from 9:44:57 UT to 11:11:25 UT, then total to 11:25:55 UT, then ending the partial at 12:52:22 UT. (For PST, subtract 7 hours; for CST, subtract 5 hours, so the eclipse will be total in Houston from 6:11 am to 6:25 am). Lunar eclipses occur at the same time for everyone (except for time zones), so if you can see the moon, you can see it eclipsed. But the folks in the East will not be able to see much of this lunar eclipse. All lunar eclipses occur at full moon, when the Moon enters the Earth's shadow.

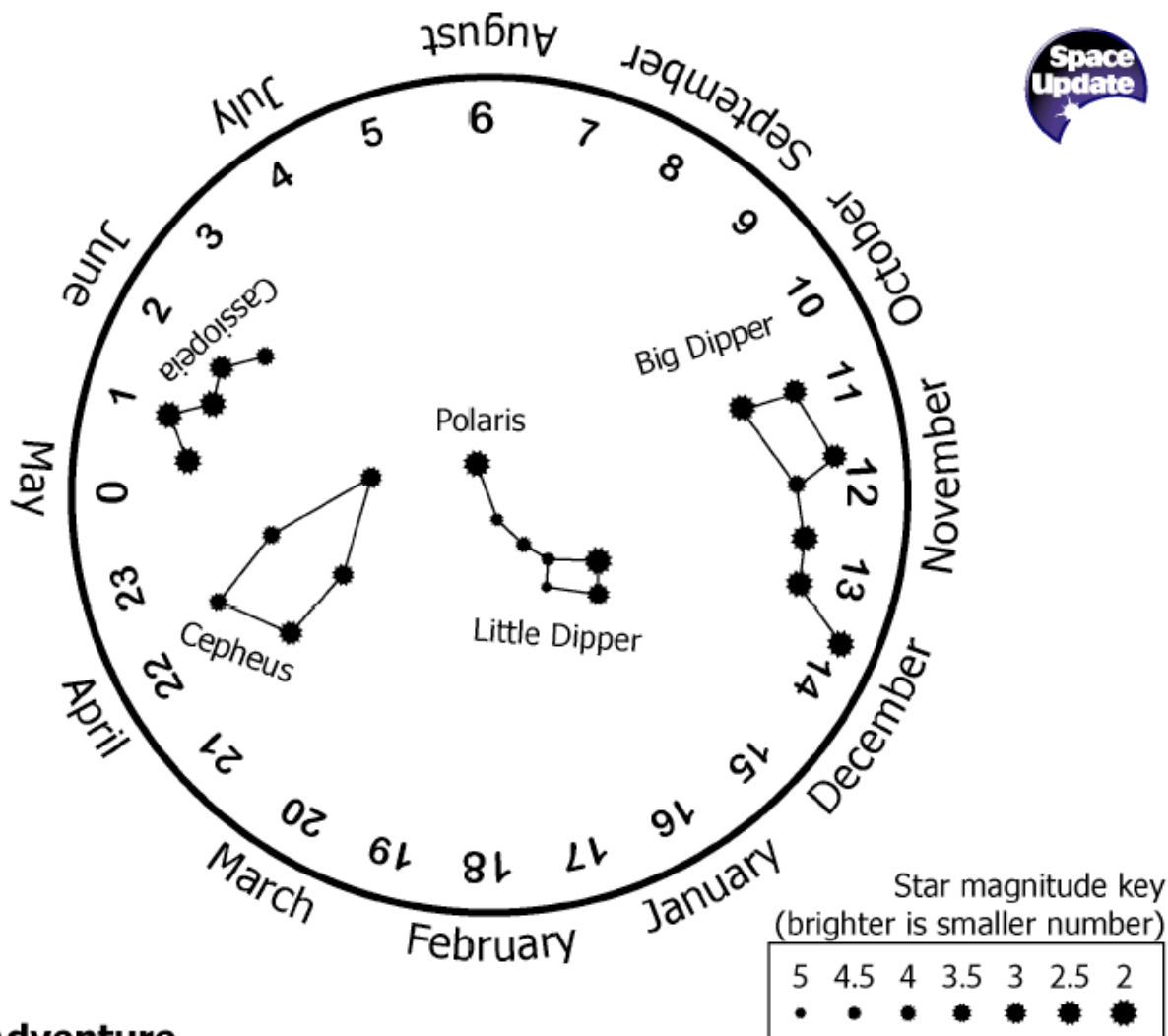
See <https://eclipse.gsfc.nasa.gov/LEplot/LEplot2001/LE2021May26T.pdf> for details. For other upcoming lunar eclipses, see <https://eclipse.gsfc.nasa.gov/LEdecade/LEdecade2021.html> May 16, 2022 will be visible across most of the continental US (actually late evening on the 15th, local time). There will also be a total eclipse two weeks after the annular eclipse, Nov 8, 2022, also visible across the US. <https://eclipse.gsfc.nasa.gov/LEplot/LEplot2001/LE2022Nov08T.pdf> It turns out that two weeks before or two weeks after every total eclipse must be at least a partial lunar eclipse, but those eclipses for the 2023 and 2024 solar eclipses are not well placed for US observers.

PARENT INTERVIEWS

Have the students go home and "interview" their parents. Have their parents ever seen an aurora? A total eclipse of the Sun? A major meteor fireball? Emphasize that these events are very special, so that they should not be disappointed if their parents say "no." Ask their parents if they have seen a lunar eclipse or a partial solar eclipse (more common, but again their parents may not have seen one). Have the students report the stories that their parents told. What did it look like? Did the air get cool? Did the animals or birds react? Sometimes in a total solar eclipse, the sky will be cloudy so the eclipse won't be visible, but the sky will still get dark, the air will get cool, the breeze may pick up, and the birds and animals will start to roost.

NORTH SKY ADVENTURES

The next page shows the "North Sky Adventures", to help the students learn how the stars revolve around the North Star during the night and change over the year.



North Sky Adventure

Go outside in the early evening, face North, and hold this star chart in front of you. Turn the chart until the correct month is at the bottom. When you look up at the stars, the Big and Little Dippers (Ursa Major and Ursa Minor), the "W" (or "M") of Cassiopeia, and the "house" of Cepheus will be about where you see them in the chart. The elevation, or angle of the North Star, Polaris, above your horizon, equals your latitude. (Measure the elevation by using the "rule of thumb" - your fist at arm's length is about ten degrees across, and each finger about 2 degrees). For those in the Southern part of the U.S., sometimes the Big Dipper or Cassiopeia is below the horizon, but never both at once! Above about 43 degrees latitude, the Big Dipper never disappears. The "pointer stars" in the bowl of the Big Dipper (near the number 11) point to Polaris.

Advanced: Because the Earth turns, the stars will appear to rotate around Polaris through the night so that the number at top increases with time. It's called the Sidereal or "Star" Time. It's actually the celestial longitude (called Right Ascension or RA) of the stars that are overhead. At different seasons, different stars are overhead, because of the orbit of the Earth around the Sun. By knowing their Star Time, and the day and time at the Greenwich Meridian, sailors can calculate their longitude. The other star coordinate, like a latitude, is called declination. Polaris has a declination of 89° - almost at the north celestial pole. If you have a pair of binoculars, look at the stars in the handle of the Big Dipper - which one is really a double? Mizar and Alcor (the next to last star in the handle of the Big Dipper) has a declination of 55° (35 degrees from the pole). For more activities, go to: <http://tinyurl/spaceupdate> and <http://tinyurl/earthupdate>

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